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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/642,371	08/15/2003	Yong Chen	100110197-1	2549

22879 7590 08/09/2007
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EXAMINER	
DANIELS, MATTHEW J	

ART UNIT	PAPER NUMBER
1732	

MAIL DATE	DELIVERY MODE
08/09/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/642,371	Applicant(s) CHEN ET AL.	
	Examiner Matthew J. Daniels	Art Unit 1732	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 April 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-13,15-18 and 34-48* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13,15-18 and 34-48* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 23 April 2007 has been entered.

Claim Rejections - 35 USC § 102

2. Rejections set forth previously under this section are withdrawn in view of the amended claims.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Rejections set forth previously under this section are withdrawn in view of the amended claims.

4. **Claims 1-13 and 15-18** are rejected under 35 U.S.C. 103(a) as being unpatentable over Sasahara (US 2002/0012825) in view of Chou (USPN 5772905) and Zhang (Doctor of Philosophy dissertation, Princeton University, November 2001). **As to Claim 1,** Sasahara provides an article which could be used as an ion exchange membrane, the method comprising:

providing a mold having a top surface (implicit because the film is embossed);

embossing a membrane ([0038], [0039], and [0049]) to form a nanoscale recesses in the membrane ([0049]), the recess having a bottom and sidewalls extending from the surface to the bottom;

depositing a layer of catalytic material on the membrane (Par. [0057]), and it is submitted that the catalytic would have reached the bottom of the recess in view of the teaching in [0049] that the additional surface roughness creates an increase in reaction surface area, which would occur only when coated with the catalyst.

In this rejection, Sasahara provides a nanoscale pattern shown as item 126 in Fig. 8. However, Sasahara is silent to providing a mold having a top surface by establishing at least one nanoscale masking element on at least a portion of the top surface, and etching exposed portions of the mold to form at least one nanoscale protrusion therein.

However, Sasahara teaches emobossing (Par. [0021]) to produce impressed features (Par. [0019]), and an additional pattern provided with a length scale (B in Fig. 8) that is "clearly different" ([0049]) from the larger features (A in Fig. 8). Chou teaches a mold having one or more nanoscale protrusions (Fig. 1A, item 16 and Fig. 2), pressing into a membrane to form recesses having a lateral dimension of 25 nm (Fig. 1C and Fig. 2), which would implicitly have a top surface, bottom surface, and sidewalls (Fig. 1C). In the combined method, Sasahara teaches

depositing platinum, which would reach the top surface of the membrane (the high points of 126 in Fig. 8) and the recesses (between the high points in the roughness of 126). The method of Chou is interpreted to be an embossing method.

Chou suggests that the mold is patterned using electron beam lithography and reactive ion etching (4:39-49). In view of the 25 nm features of Chou (4:41), it is submitted that the claimed steps of establishing at least one nanoscale masking element and etching exposed portions would be implicit or obvious over the electron beam lithography and reactive ion etching process disclosed by Chou at 4:40-45. However, in the alternative, Zhang teaches the general process to fabricate NIL masks (page 40), which includes providing a mold having a top surface (Fig. 3.2, Initial substrate), providing at least one nanoscale masking element on the top surface (Fig. 3.2, Photolithography or EBL), etching exposed portions of the mold to form protrusions (Fig. 3.2, SiO2 or RIE) which are of a nanoscale size (pages 40-45, especially pillars on page 45). Note also that the author of the Chou reference was the advisor for the Zhang dissertation.

It would have been prima facie obvious to one of ordinary skill in the art at the time of the invention to incorporate the methods of Chou and Zhang into that of Sasahara for the following reasons:

a) Sasahara, Chou, and Zhang teach each of the claimed steps. One of ordinary skill could have combined the elements of Chou and Zhang with Sasahara using known methods in view of Sasahara's teaching of embossing, which would require a mold and a method of making a mold. In the combination, the aspects provided by Zhang and Chou each perform the same function as

they did separately, with the predictable result of providing a mold having a nanometer length scale which would increase the surface area of an embossed surface.

b) Sasahara suggests an embossing process for producing the membrane and increasing the surface area ([0021], [0049], [0062]), and Chou and Zhang provide an embossing process and a method of making a mold for use in an embossing process. A reasonable expectation would be implicit in that Chou and Zhang imprint upon a polymeric film, and Sasahara uses a polymeric film or membrane.

As to Claims 2-5, Sasahara teaches a membrane that is an ion conductive polymer electrolyte membrane of perfluorosulfonic acid polymer (commercially known as Nafion (DuPont), which is inherently ion conducting and comprised of perfluorosulfonic acid polymer, Par. [0038]). **As to Claim 6**, Chou teaches a mold comprising a substrate and a molding layer including an array of protruding features having nanoscale dimensions (Fig. 1A, Items 12 and 14). Also see Zhang, pages 40-48. **As to Claims 7 and 8,** Chou provides nanoscale protrusions having a lateral dimension of about 25 nm (Fig. 2) and a height of about 100 nm (3:40). Also see Zhang, pages 40-48. **As to Claim 9**, Chou provides a pillar shape (Figs. 1-2). Also see Zhang, pages 40-48. **As to Claims 10-13**, Chou provides a regular pattern where the recesses have the obverse shape of the protrusions, the bottom of the recesses being parallel to the top surface, and the sidewalls are perpendicular to the bottom of the recesses and top surface of the membrane (Figs. 1-2). Also see Zhang, pages 40-48. **As to Claim 15**, Chou teaches that in depositing material on an embossed surface, it is conventional for the sidewalls to be substantially free of catalytic material (Fig. 5A). Therefore, in the deposition of catalytic material in Sasahara, it is submitted that the claimed effect would have been obvious. **As to Claim 16**, the electrode of

Sasahara (Item 34 in Fig. 2), placed into contact with the catalyst surface (Item 38 in Fig. 2) would cause the catalytic material to also act as an electrode. **As to Claims 17 and 18**, see Sasahara's teaching of platinum (Par. [0030]).

5. **Claims 34-48** are rejected under 35 U.S.C. 103(a) as obvious over Sasahara (US 2002/0012825) in view of Chou (USPN 5772905). **As to Claim 34,** Sasahara teaches a method of making nanoscale catalyst patterns comprising:

Providing a malleable ion exchange membrane having a top surface ([0021]);

Providing a mold (implicit because the film is embossed);

Imprinting the mold into the membrane (embossing, [0021]) to form at least one nanoscale recess having a bottom and sidewalls, wherein the sidewalls extend from the top surface of the membrane to the bottom of the at least one recess (Fig. 4B, item 66 or Fig. 8, item 126); and

Depositing a layer of catalytic material on the membrane (Par. [0057]). It is submitted that the catalytic would have reached the bottom of the recess in view of the teaching in [0049] that the additional surface roughness creates an increase in reaction surface area, which would occur only when coated with the catalyst.

Sasahara does not specifically teach a mold having nanoscale protrusions. However, Chou teaches that molds with nanoscale protrusions are used in an imprinting process, which is interpreted to be an embossing process (4:39-49, Fig. 1A-1C).

It would have been prima facie obvious to one of ordinary skill in the art at the time of the invention to incorporate the method of Chou into that of Sasahara for the following reasons:

a) Sasahara and Chou teach each of the claimed steps. One of ordinary skill could have combined the elements of Chou with Sasahara using known methods in view of Sasahara's teaching of embossing, which would require a mold. In the combination, the aspects provided by Chou perform the same function as it did separately, with the predictable result of providing a mold having a nanometer length scale which would increase the surface area of an embossed surface.

b) Sasahara suggests an embossing process for producing the membrane and increasing the surface area ([0021], [0049], [0062]), and Chou provides an imprinting process, which is interpreted to be an embossing process. A reasonable expectation would be implicit in that Chou's process imprints a polymeric film, and Sasahara uses a polymeric film or membrane.

As to Claims 35-37, Sasahara teaches a membrane that is an ion conductive polymer electrolyte membrane of perfluorosulfonic acid polymer (commercially known as Nafion (DuPont), which is inherently ion conducting and comprised of perfluorosulfonic acid polymer, Par. [0038]). **As to Claim 38**, Sasahara is silent to the claimed substrate and molding layer. However, Chou teaches a mold comprising a substrate and a molding layer including an array of protruding features having nanoscale dimensions (Fig. 1A, Items 12 and 14).

It would have been prima facie obvious to one of ordinary skill in the art at the time of the invention to incorporate the method of Chou into that of Sasahara because Sasahara clearly suggests embossing ([0021]), fabrication with known micromachining techniques which would provide the advantages of fine resolution and high repeatability (Par. 0050]), and that the second pattern (126 in Fig. 8) may have a prescribed pattern ([0049]). Chou provides a known micromachining technique having fine resolution and high repeatability, and the ability to

provide a prescribed additional pattern which could be varied to achieve any desirable roughness. Expectation of success would have been implicit in view of Chou's teaching of imprinting of a polymeric layer, and Sasahara's teaching of a polymeric film or layer.

As to Claim 39, Sasahara clearly teaches the claimed height and lateral dimensions (Pars. [0019] and [0049]) for the larger features or inherent teaching about the size of the mold that produces those features. Use of protrusions having sizes of 5-10 microns would have been inherent or obvious in order to create impressions having that size (Par. [0019]). The Examiner's position is that the teaching of Sasahara contains sufficient specificity to anticipate the claimed size, but in the alternative, the claimed size would have been prima facie obvious as it comprises approximately 20% of the range of Sasahara. Also see Chou's teaching of particular feature sizes and dimensions (Fig. 2). **As to Claim 40**, the Examiner interprets the shape of the protrusions of Sasahara to fall within the scope of a "pillar". However, in the alternative, Sasahara suggests that the particular pattern and shape should be varied according to the purpose (Par. [0039] and [0043]). Also see the method of Chou, Fig. 1A, item 16. **As to Claims 41 and 42**, Sasahara does not explicitly teach the nanoscale protrusions having a regular pattern or that the resulting pattern has an obverse shape of the protrusions. However, Sasahara clearly teaches that the resulting impressions have a regular pattern, the embossed imprints would inherently replicate the shape of the protrusions used to create them (Pars. [0039]-[0043]). **As to Claim 43**, when the features in Figs. 2, 3B and 4B are interpreted as the features or recesses, the bottom of the recesses are parallel or substantially parallel to the top surface of the membrane, and the side walls are perpendicular to the bottom of the recess and the surface of the membrane (Figs. 2, 3B, 4B). **As to Claim 44**, Sasahara teaches a depth within the claimed range (Pars. [0019], [0039],

and [0049]). **As to Claim 45**, Sasahara is silent to the sidewalls remaining free of catalytic material. However, Sasahara clearly suggests depositing catalytic material (Pars. [0006] and [0037]). Chou teaches that in depositing material on an embossed surface, it is conventional for the sidewalls to be substantially free of catalytic material (Fig. 5A). **As to Claim 46**, the electrode of Sasahara (Item 34 in Fig. 2), placed into contact with the catalyst surface (Item 38 in Fig. 2) would cause the catalytic material to also act as an electrode. **As to Claim 47**, see platinum (Par. [0030]). **As to Claim 48**, Chou teaches a lateral dimension of about 25 nm (Fig. 2), and Sasahara suggests that the length scales of the two types of surface features are "clearly different" ([0049]) such that the length scale of item 126 is smaller.

Response to Arguments

6. Applicant's arguments filed 23 April 2007 have been fully considered but they are not persuasive. The arguments appear to be on the following grounds:

a) Applicants argue on pages 7 to 8 that the dictionary definition of embossing requires something to bulge out or become protuberant. As such, Applicants assert that the embossing technique of Sasahara forms protrusions.

b) Sasahara teaches forming three-dimensional features in interfaces having a width between 5 and 500 microns and a depth between 1 and 5 microns. As such, one cannot conclude that the nanoscale features are suitable for reactant flow.

c) Chou does not disclose forming the mold patterned with features including pillars, holes, and trenches with a minimum lateral feature size of 25 nm.

7. <u>These arguments are not persuasive for the following reasons:</u>

a) As a rebuttal to Applicants' supplied dictionary definition, it is asserted that in this art, the term "imprinting" and "embossing" are now used interchangeably. As evidence of this position, the Examiner cites the following references:

N. Roos *et al*, First and second generation purely thermoset stamps for hot embossing, Microelectronic Engineering, Vol. 61-62 (2002) 399-405.

H. Schift et al, Chemical nano-patterning using hot embossing lithography, Microelectronic Engineering, Vol. 61-62 (2002) 423-428.

Roos teaches (page 400, Section 2.1) a silicon template is "embossed into" a spin coated film. Roos also shows the stamp or template and the resulting "imprint thereof" in the caption for Fig. 5 (page 404). Schift teaches "embossing" by placing a thermoplastic film on a substrate and using pressure and heat to create a pattern therein (Fig. 1, page 424). Note the substantial similarity between Fig. 1 of Schift and Figs. 1B-1C of the Chou reference. It is submitted that the term "embossing", as used in this art, encompasses imprinting.

As further support for this position, note Figs. 3B and 4B of Sasahara, and in particular, the perimeter on either side of the shaped portion, which appears flat. It is submitted that in Figs. 3B and 4B there is no portion which is raised above the plane of the film. Thus, the features depicted in these figures appear to be imprints, rather than conforming to the proffered definition of "embossing".

b) This position does not appear to be supported by evidence, and does not appear to be commensurate with the scope of the claim, which does not require any reactant flow. It is noted that the method of Sasahara is directed at increasing the surface area (Abstract, [0006], [0014], [0039]), and would therefore appear to suggest any process which increases the surface area. Only "Typical" ([0039], line 7) size values are provided, and thus it is submitted that the Sasahara provides only preferred embodiments. Additionally, this argument appears to be directed only at the size of features 38 and 40. However, the rejection is based on the position that either the rectangular features (38, 40) or the additional superimposed pattern ([0049], 126, 128) are provided by embossing and read on the claimed invention. The size of features 126 and 128 is "clearly different" ([0049]) such they fit on or into the larger rectangular features, as shown in Fig. 8.

Additionally, Applicants define "nanoscale" in Par. [0003] of the specification to be one nm to 100 microns (i.e. one nm to 100,000 nm), and it is submitted that this defined range would read on either length scale of Sasahara or Chou.

c) Applicants argue against any disclosure of a method of making a mold in the method of Chou. A new reference is set forth above (Zhang) which shows how masking and reactive ion etching are used to provide nanoscale surface features.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Daniels whose telephone number is (571) 272-2450. The examiner can normally be reached on Monday - Friday, 8:00 am - 4:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Christina Johnson can be reached on (571) 272-1176. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J. Daniels

A.U. 1732
6 August 2007